National Aeronautics and Space Administration Request for Information: Laser Communications Relay Demonstration Commercial Applications

Introduction

The ever increasing desire for higher data rates and other considerations have lead satellite communications systems to utilize higher radio frequency (RF) bands. Even with this progression, the frequency allocations and other limitations inherent with RF communications will drive the commercial space communications sector to consider alternative technologies. NASA's current technology investments include the development and demonstration of space optical communications to support future science and exploration missions. NASA acknowledges that the commercial communications satellite industry also has significant interest in optical communications to provide improved efficiency (bandwidth to power), expanded access to bandwidth, and diverse products such as point-to-point services. NASA seeks suggestions on methods for the agency to energize/stimulate/enable commercial optical communications capabilities utilizing NASA's Laser Communications Relay Demonstration (LCRD) project.

This is a Request for Information (RFI) only and does not constitute a commitment, implied or otherwise, that the National Aeronautics and Space Administration (NASA) will take procurement action in this matter. Further, neither NASA, nor the Government will be responsible for any costs incurred in furnishing this information.

Background

The Laser Communications Relay Demonstration (LCRD) project will serve as NASA's pathfinder mission towards the optical relay capability. LCRD is a Space Technology Mission Directorate (STMD) technology demonstration mission that is co-funded by NASA's Space Communications and Navigation (SCaN) program. The LCRD architecture and experiment plan are designed to address the critical questions remaining to move the technology to operational readiness. LCRD will address questions beyond whether or not the technology will work; it will address questions regarding how the technology can optimally function in an operational setting.

The LCRD architecture is illustrated in Figure 1. The LCRD flight payload, consisting of two optical space terminals and associated electronics, will be hosted onboard a Space Systems Loral-built communications satellite. The satellite operator will have a host mission operations center (HMOC) to route payload commands and telemetry. LCRD will also have two ground stations: Ground Station 1 (GS-1) located in Table Mountain, California and Ground Station 2 (GS-2) located in White Sands, New Mexico. The LCRD Mission Operations Center (LMOC) located at NASA GSFC will coordinate ground station and payload operations.

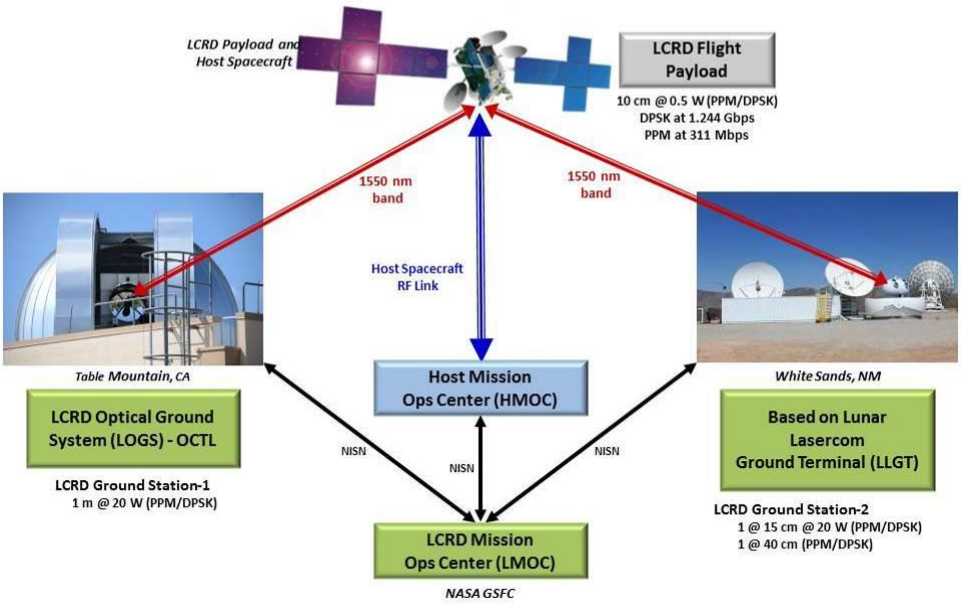

Figure 1. The LCRD Architecture

The LCRD flight payload system diagram is seen in Figure 2. LCRD will fly two optical space terminals, each comprised of an optical module, controller electronics, and modem. A Space Switching Unit (SSU) will connect the two optical links together for real-time relay services.

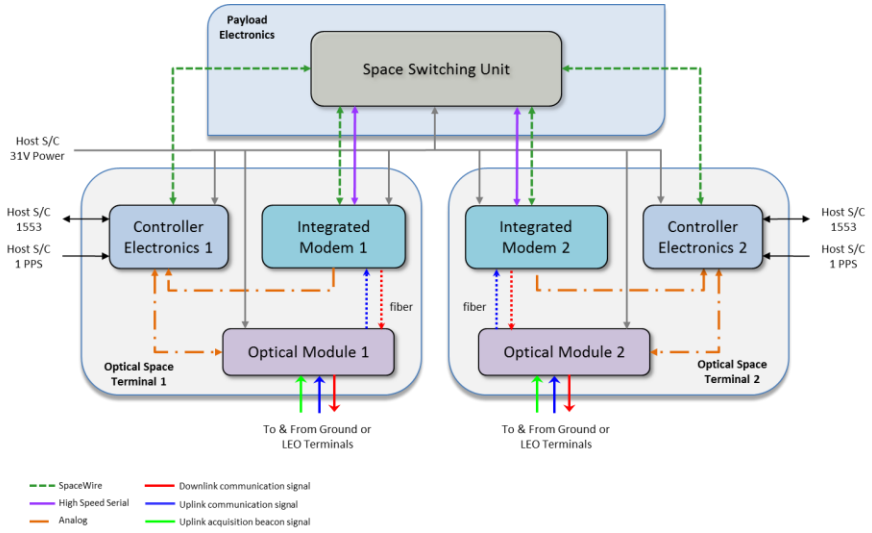

Figure 2. LCRD Flight Payload

The LCRD modems will feature the Pulse Position Modulation (PPM), recently demonstrated on the Lunar Laser Communication Demonstration (LLCD), as well as Differential Phase Shift Keying (DPSK) modulation. Though PPM allows for communications in photon-starved scenarios, such as deep space links, DPSK will allow for extremely high data rates (10's of Gbps). The data rates for all links will support up to 311 Mbps in PPM and up to 1.244 Gbps in DPSK.

The LCRD ground segment is comprised of the LMOC and two ground stations. The LMOC will provide a central location for all scheduling, control, and monitoring of the flight payload and the ground stations. Any handovers or other variations in ongoing or planned activities will initiate via the LMOC. The location will examine and evaluate various approaches to operate the overall optical relay network.

Ground Station 1 (GS-1) will be located at the JPL Optical Communications Telescope Laboratory (OCTL) facility and Ground Station 2 (GS-2) will be based upon the Lunar Lasercom Ground Terminal (LLGT). A general block diagram for either ground station is seen in Figure 3.

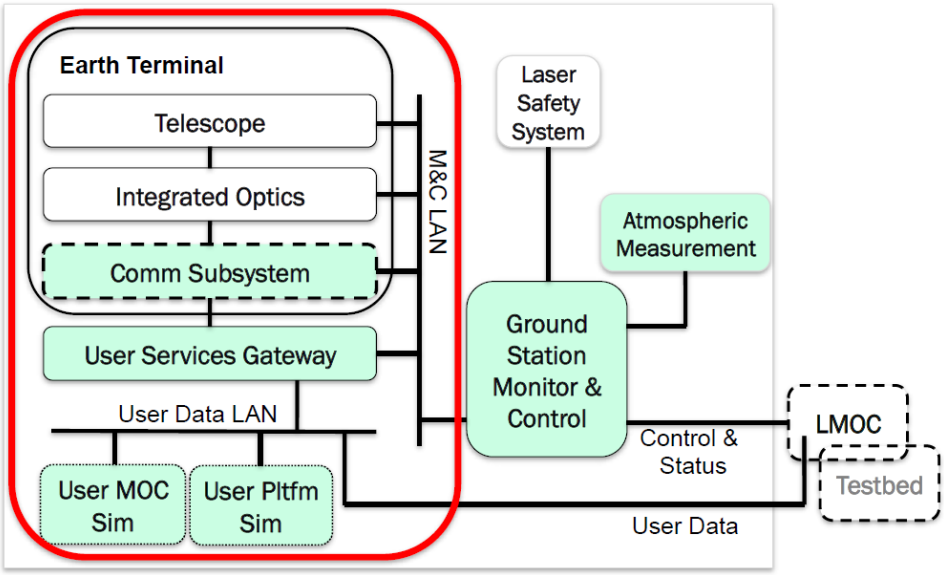

Figure 3. Ground Station Block Diagram

The telescope assembly subsystems are capable of transmitting and receiving laser light while pointing towards the LCRD flight payload. GS-1 will use a one-meter telescope for both the uplink and downlink, while GS-2 will use a single 15 cm telescope for uplink and 40 cm telescope for downlink.

Since LCRD includes DPSK demodulation using single mode optical components, the ground stations require adaptive optics in their Integrated Optics. Different approaches to adaptive optics have been examined during the LCRD design phase. The results of the design trades, as well as the performance results during the mission, will inform the design of future ground stations.

The communications subsystem includes the ground modem and the system for encoding, decoding, interleaving, and de-interleaving the data streams. The ground modem performs the same functionality as the flight payload modems, but the flight payload does not require the other data processing functions. The communications subsystem will have the ability to support up to three different encoded data channels and three bypass channels on a multiplexed trunkline.

The LCRD User Services Gateway (USG) is the interface between the LCRD Network and users for data transfer services. The USG supports real-time frame and symbol stream services, as well as interfaces for higher layer services, such as IP packets and DTN bundles. The USG can (de)multiplex different users and data streams within any of the potential trunkline channels. The USG also provides the interface to allow the inline command and telemetry flows between the LMOC and Flight Payload over the optical links.

In order for LCRD to perform demonstrations of complex scenarios and exercise all of the possible data paths and modes, a User Platform Simulator (UPS) and User Mission Operations Center Simulator (UMS) will be located at each ground station. The simulators will allow high rate data streams to flow over the optical links without requiring high data rate connections out from the ground stations. The inclusion of the service interfaces and simulators enables LCRD to service real users as they come online.

LCRD is planned for two years of operations with a goal for at least five years. This experiment duration, much greater than LLCD's month of operations, will allow extended characterization of hardware performance, link performance, atmospheric effects, and operational approaches. The extended operations will allow model refinement and validation, the examination of different network schemes, the optimization of handover approaches and the provision of key data to determine the needed number and distribution of ground stations for a future operational capability that minimizes user data loss and ensures system availability.

Timeline

LCRD is planned to launch in the 2018 timeframe for a two year on-orbit demonstration. The payload will be hosted on a commercial spacecraft with a longer expected lifetime. Commercial participation is desired during all phases of the project. This includes the mission planning period already underway, the two-year primary post-launch demonstration and experiment phase, and any follow-on phase available beyond the primary experiment period.

Government Resources and Capabilities

NASA will design, integrate, test, and deliver the ground stations, flight payload, and LCRD Missions Operations Center. Commercial entities will be invited to propose, define, and participate with the Principal Investigator team in experiments and demonstrations.

Description of Information Requested

RFI responses must include:

1. Respondent Information
    a. Name of Respondent;
    b. Respondent's address;
    c. Name and contact information for primary Respondent Point of Contact (POC), including POC's name, title (or affiliation with Respondent entity), email address, and phone number;

d. General description of Respondent's capabilities and experience in the subject matter of this RFI; and
e. Business size

RFI Questions

1. How do you envision optical communications enabling your operations and customer services? (This can be for future optical communication systems running at much higher data rates than what is planned in LCRD)
2. What data rates would you like to see optical communication terminals provide on the Space to Ground Link? On the Space to Space Link? Do the links need to be symmetrical?
3. What types of optical communications scenarios or capabilities are of greatest interest to either augment current RF capabilities or provide for entirely new space based communication markets?
4. What type of experiments or demonstrations would you like to see performed with LCRD?
5. What concerns do you have about optical communications technology and operations?
6. How could optical communications technology drive innovations in commercial satellite operations and services?
7. Would you like to participate in the planning and/or performance of some LCRD experiments and demonstrations? How do you envision/desire this participation to occur?
8. How do you recommend that NASA share the results of various LCRD experiments with the telecommunications industry?

Disclaimer

It is not NASA's intent to publicly disclose Respondents' proprietary information obtained in response to this RFI. To the full extent possible pursuant to the Freedom of Information Act and other laws and regulations, information identified by a Respondent as "Proprietary or Confidential" will be kept confidential.

It is emphasized that this RFI is NOT a Request for Proposal, Quotation, or Invitation for Bid. This RFI is for information and planning purposes only, subject to FAR Clause 52.215-3 titled "Solicitation for Information or Planning Purposes," and is NOT to be construed as a commitment by the Government to enter into a contractual agreement. The Government will not pay for information submitted in response to this RFI. No solicitation exists; therefore, do not request a copy of the solicitation. If a solicitation is released, it will be synopsized in the FedBizOpps or NASA Acquisition Internet Service websites. It is the responsibility of any potential offerors/bidders to monitor these sites for the release of any solicitation, synopsis, or related documents.

The Government reserves the right to consider a small business or 8(a) set-aside based on responses hereto. As part of its assessment of industry capabilities, the NASA-GSFC may contact respondents to this Request for Information, if clarifications or further information is needed.

Responding to this RFI

An entity responding to this RFI must be a U.S. domestic entity. All RFI queries must be submitted via e-mail to both points of contact outlined below.

How to Respond

All final submissions shall be submitted via e-mail to both points of contact listed below no later than October 20, 2014, 5:00 pm Eastern Daylight Time. Two hardcopies of the final submission shall be sent to:

NASA Goddard Space Flight Center

ATTN: Denise A. Byrd, Contracting Officer

8800 Greenbelt Road

Mail Stop: 210.4

Greenbelt, MD 20771

Please reference **NNG14VS03L-LCRD** in any response.

Files may be submitted in MS Word, PowerPoint, PDF, or RTF format. NO CLASSIFIED INFORMATION SHOULD BE INCLUDED IN THIS RFI RESPONSE.

Point of Contact

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Contracting Officer notes:

N/A